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#### (54) Co-Cr-Pt-B BASED TARGET AND MAGNETIC RECORDING MEDIUM

##### (57)Abstract:

PROBLEM TO BE SOLVED: To provide a Co-Cr-Pt-B based target having a fine and uniform structure.

SOLUTION: The Co-Cr-Pt-B based target having a fine and uniform structure, can be obtained by controlling an average diameter of a cell, that is divided by a net work formed by a boride, to be 200  $\mu\text{m}$ .

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##### [Claim(s)]

[Claim 1]A Co-Cr-Pt-B system target, wherein a pitch diameter of a cell divided by a network currently formed with a boride is 200 micrometers or less.

[Claim 2]The Co-Cr-Pt-B system target according to claim 1, wherein an average crystal grain diameter of a matrix is 40 micrometers or less.

[Claim 3]Dispersion in a pitch diameter of a cell divided by a network currently formed with a boride, The Co-Cr-Pt-B system target according to any one of claims 1 to 2 being 0.5-2.0 in target surface part pitch-diameter  $a_S$ /target central part pitch-diameter  $a_M$ .

[Claim 4]The Co-Cr-Pt-B system target according to any one of claims 1 to 3, wherein dispersion in an average crystal grain diameter of a matrix is 0.5-2.0 in target surface part mean-particle-diameter  $b_S$ /target central part mean-particle-diameter  $b_M$ .

[Claim 5]The Co-Cr-Pt-B system target according to any one of claims 1 to 4 becoming a remainder real target from Co 10 <=Cr<=30at% 5 <=Pt<=30at% 1 <=B<=15at%.

[Claim 6]The Co-Cr-Pt-B system target according to any one of claims 1 to 5 being  
0<(Ti+Zr+Hf+V+Nb+Ta+Mo+W+Mn+Re+Ru+Os+Rh+Ir+nickel+Pd+Cu+Ag+Au+C)  
<40at%.

[Claim 7]A magnetic recording medium currently forming at least one or more layers of Co-Cr-Pt-B system thin films which used the target according to any one of claims 1 to 6, and formed membranes on a nonmagnetic substrate

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#### [Detailed Description of the Invention]

##### [0001]

[Field of the Invention]This invention relates to the Co-Cr-Pt-B system target and magnetic recording medium which are used in order to form the magnetic film of the magnetic recording medium used for a magnetic disk drive etc.

##### [0002]

[Description of the Prior Art]Conventionally, Co system magnetic film is developed so that high-density magnetic recording may become possible, and addition of Ta or Pt has been performed to Co system magnetic film. It is reported to J.Appl.Phys.84, 6202(1998)., etc. by adding B to Co system magnetic film that magnetic properties are improved remarkably.

[0003]As a method of producing this Co system magnetic film, sputtering process etc. can be used so that it may be indicated in the literature etc. which were mentioned above. In sputtering process, the target used as the supply source of film composition is needed. The target used in order to form Co system magnetic film in which above-mentioned B was added usually slices and produces the ingot cast and made to the mold made from cylindrical Fe in predetermined thickness.

##### [0004]

[Problem(s) to be Solved by the Invention]this invention person examined the target for forming Co system magnetic film which is indicated to above-mentioned J.Appl.Phys.84 and 6202(1998). As a result, the problem which dispersion produces in the magnetic properties of the coercive force and the square-shaped ratio of a magnetic film which were produced occurred.

[0005]Since a casting target was formed with a to some extent detailed chill crystal, the columnar crystal for which it is big and rough and depends in the cooling direction, and to some extent big and rough equiaxed grain, its crystal is big and rough and uneven, and it had become a cause which dispersion produces in the magnetic properties of the coercive force and the square-shaped ratio of a magnetic film in this. The purpose of this invention is to provide the Co-Cr-Pt-B system target which has a detailed and uniform

organization.

[0006]

[Means for Solving the Problem]A problem which dispersion produces in the characteristic of a magnetic film when this invention person uses a casting target of a Co-Cr-Pt-B system which sliced and produced an ingot cast and made to a mold made from cylindrical Fe in predetermined thickness as a result of examination, It found out that it was dependent on a size of a cell, i.e., a dendrite, divided by a network currently formed with a boride, and this invention was reached.

[0007]That is, this invention is a Co-Cr-Pt-B system target whose pitch diameter of a cell divided by a network currently formed with a boride is 200 micrometers or less.

[0008]As for a Co-Cr-Pt-B system target of this invention, it is preferred that an average crystal grain diameter of a matrix is 40 micrometers or less.

[0009]A Co-Cr-Pt-B system target of this invention, Dispersion in a pitch diameter of a cell divided by a network currently formed with a boride, Target surface part pitch-diameter  $a_S$  (it is hereafter considered as  $a_S$ ) / target central part pitch-diameter  $a_M$ . It is preferred that it is 0.5-2.0 in (it is hereafter considered as  $a_M$ ), It is more preferred that dispersion in an average crystal grain diameter of a matrix is 0.5-2.0 in target surface part mean-particle-diameter  $b_S$  (it is hereafter considered as  $b_S$ ) / target central part mean-particle-diameter  $b_M$  (it is hereafter considered as  $b_M$ ).

[0010]As a desirable presentation of a Co-Cr-Pt-B system target of this invention, it is  $Co\ 10 \leq Cr \leq 30at\%$   $5 \leq Pt \leq 30at\%$   $1 \leq B \leq 15at\%$  at a remainder real target. Ti, Zr, Hf, V, Nb, Ta, Mo, W, Mn, Re, Ru, Os, Rh, Ir, nickel, Pd, Cu, Ag, one sort or two sorts or more of elements chosen from Au and C --  
 $0 < (Ti + Zr + Hf + V + Nb + Ta + Mo + W + Mn + Re + Ru + Os + Rh + Ir + nickel + Pd + Cu + Ag + Au + C) < 40at\%$  -- containing is also possible.

[0011]It becomes possible by forming a Co-Cr-Pt-B system magnetic film using a Co-Cr-Pt-B system target of this invention to be stabilized and to perform manufacture of a magnetic recording medium.

[0012]

[Embodiment of the Invention]There is the greatest feature of this invention in having made detailed equalization the pitch diameter of the cell divided by the network currently formed with the boride in the Co-Cr-Pt-B system target. The cell divided by the network currently formed with the boride has big influence on the distributed degree of the boride of a target. When the distributed degree of this boride forms a magnetic film by sputtering using a target, the homogeneity of the magnetic properties of a magnetic film is affected.

[0013]Then, by carrying out detailed equalization of the pitch diameter of the cell divided by the network currently formed with the boride, the Co-Cr-Pt-B system target of this

invention controls the coercive force of a magnetic film, and dispersion of the magnetic properties of a square-shaped ratio, and brings about stable manufacture of a magnetic recording medium. The reason which limited the pitch diameter of the cell divided by the network currently formed with the boride with 200 micrometers or less is for the homogeneity of the magnetic properties of a magnetic film to deteriorate remarkably, when the pitch diameter of a cell exceeds 200 micrometers.

[0014]Methods of carrying out minuteness making of the pitch diameter of the cell divided by the network currently formed with the boride of the Co-Cr-Pt-B system target of this invention include the method of bringing forward the cooling rate at the time of casting of a target, for example.

[0015]In the alloy in which B was added, since the supercooling at the time of coagulation becomes large, detailed equiaxed grain is formed comparatively easily by speeding up the cooling rate at the time of casting. Therefore, the cell divided by the network currently formed with the boride becomes detailed. Although there is lowering the method of raising the cooling power of the mold itself, the method of making thickness of an ingot thin, and casting temperature as a concrete method of speeding up the cooling rate at the time of casting etc., the method of water-cooling producing a mold with construction material with high cooling power, such as Cu, and the mold itself, etc. are mentioned. It becomes possible to carry out minuteness making of the pitch diameter of the cell divided by the network currently more simply formed with the boride by using these methods. Although some affect a cooling rate as for the atmosphere which performs the dissolution and casting, it is preferred to carry out in the vacuum in which gas constituents, such as oxygen in a target, are reduced.

[0016]Perform hot-rolling and plastic working between heat like hot forging to the target material which set to 200 micrometers or less the pitch diameter of the cell divided in the Co-Cr-Pt-B system target of this invention by the network currently formed with the boride, and a matrix is made to recrystallize, By the average crystal grain diameter of a matrix being 40 micrometers or less, since the coercive force of the magnetic film of a Co-Cr-Pt-B system sputter film and dispersion of the magnetic properties of a square-shaped ratio are reduced further, they are preferred.

[0017]As a method of asking for the pitch diameter and matrix mean particle diameter of a cell which are divided by the network currently formed with the boride, For example, it is possible to use the method of observing the microstructure of the surface part of a target and the central part which produced with an optical microscope from a sputtering surface, and measuring with an intercept method based on the observation photograph.

[0018]What the pitch diameter of a cell and the average crystal grain diameter of a matrix which are divided in the Co-Cr-Pt-B system target of this invention by the network currently formed with the boride have dispersion for, Since it becomes a cause of dispersion of membrane characteristics, especially aging at the time of weld slag membrane formation, Since dispersion in the pitch diameter of the network which the boride forms can control aging at the time of weld slag by being  $0.5-2.0$  in  $a_S/a_M$ , it is

preferred, In order to acquire the effect furthermore, dispersion in the average crystal grain diameter of a matrix is possible by considering it as  $b_S/b_M$ .

[0019]The target with little dispersion in the pitch diameter of the cell divided by the network currently formed with such a boride becomes possible by cooling uniformly quickly making cooling at the time of casting quicker, and, for example by making thickness of an ingot thin.

[0020]The target with little dispersion in the average crystal grain diameter of a matrix becomes producible by controlling plastic-working conditions between heat, such as working ratio at the time of plastic working between heat, for example. Since dispersion will specifically become large with the anisotropy at the time of plastic working between heat if working ratio is too high, and no recrystallization sets and there is when too low, there is no effect of plastic working between heat. When hot-rolling as plastic working between heat, since the anisotropy of the organization by rolling seldom appears by performing crossing rolling, it is desirable. It is also possible to heat-treat before and after plastic working between heat, and to perform structure control.

[0021]The desirable composition range of the Co-Cr-Pt-B system target of this invention is  $\text{Co } 10 \leq \text{Cr} \leq 30\text{at\%}$   $5 \leq \text{Pt} \leq 30\text{at\%}$   $1 \leq \text{B} \leq 15\text{at\%}$  at a remainder real target. Addition limitation of each element is explained in detail below.

[0022]The segregation of the B is carried out to a grain boundary in a film, it has an effect to which the segregation of the Pt element is carried out into a grain, there is an effect to which the segregation also of the nonmagnetic elements, such as Cr, is further carried out to a grain boundary, and these effects become remarkable by addition beyond 1at%. If addition which is an element which promotes amorphous-ization and exceeds 15at% is performed, in order that B may spoil membranous crystallinity and may degrade membranous magnetic properties, it is desirable. [  $1 \leq \text{B} \leq 15\text{at\%}$  of ]

[0023]By dissolving to Co, Pt improves magnetic anisotropy and is effective in raising membranous coercive force. The addition which a prominent effect is seen and exceeds 30at% by carrying out addition beyond 5at% to coercive force increase is [  $5 \leq \text{Pt} \leq 30\text{at\%}$  of ] desirable in order to reduce remarkably magnetic properties, such as magnetic anisotropy which is the characteristic which Co originally has.

[0024]By carrying out a segregation to a grain boundary in a film, and making a grain boundary nonmagnetic, Cr has an effect divided magnetically for ferromagnetic Co grain, and in addition below 10at%. Magnetic division is not enough, and the addition exceeding 30at% is [  $10 \leq \text{Cr} \leq 30\text{at\%}$  of ] desirable in order to reduce magnetization of the film itself too much.

[0025]Ti, Zr, Hf, V, Nb, Ta, Mo, W, Mn, Re, Ru, Os, Rh, Ir, nickel, Pd, Cu, Ag, Au, and C addition can be added as an alloying element which improves magnetic properties. Although an effect is accepted by a little addition, these elements, If 40at% is exceeded in a total amount, in order to spoil membranous magnetic properties and crystallinity

remarkably,

0<(Ti+Zr+Hf+V+Nb+Ta+Mo+W+Mn+Re+Ru+Os+Rh+Ir+nickel+Pd+Cu+Ag+Au+C)<40at% is preferred.

[0026]

[Example](Example 1) The target with the presentation of Co-20Cr-10Pt-5B (at%) of phi101-mm<sup>x</sup>5mm<sup>t</sup> was produced on the casting condition and hot-rolling conditions which are shown in Table 1. The weld slag surface part of the produced target and the central part of a thickness direction each Central blank test material. The result of having measured the pitch diameter and matrix mean particle diameter of the cell which are divided by the network which extracts (the following and TP), performs a microstructure with a sputtering surface to an optical microscope from the TP, and is formed with the boride of the intercept method is shown in Table 2. However, the pitch diameter and matrix mean particle diameter of the cell which are divided by the network currently formed with the boride were made into the average value of each surface part and the central part.

[0027]Since the matrix of the target which has not hot-rolled was not recrystallized but comprised a broad view crystal, since measurement of strict mean particle diameter was difficult, it made it incapable measurement with the optical microscope. The microstructure photograph of the sample 5 and the sample 10 is shown in drawing 1 and 2 as a typical organization of the target of this invention, respectively. The pitch diameter of the cell of the network which the boride forms is understood that the detailed thing made uniform is possible by controlling the construction material and ingot thickness of a mold from Table 1, Table 2, drawing 1, and drawing 2. The ceramics shown in the samples 11 and 12 of Table 1 are molds used when casting with a lost wax process.

[0028]

[Table 1]

試料	鋳型材質	インゴット厚 (mm)	圧延率 (%)
1	C u	2 5	2 5
2	C u	3 0	2 5
3	C u	3 5	2 5
4	C u	4 0	0
5	C u	4 0	2 5
6	C u	4 0	5 0
7	F e	2 5	2 5
8	F e	3 5	0
9	F e	3 5	2 5
10	F e	4 0	2 5
11	セラミックス	2 5	2 5
12	セラミックス	4 0	2 5

[0029]

[Table 2]

試料	セル 平均径 ( $\mu\text{m}$ )	表面部 セル 平均径 ( $\mu\text{m}$ )	中心部 セル 平均径 ( $\mu\text{m}$ )	表面/中心 セル平均径 比率	備考
1	27	24	30	0.80	本発明例
2	35	31	39	0.79	本発明例
3	41	34	48	0.71	本発明例
4	53	40	65	0.62	本発明例
5	53	41	65	0.63	本発明例
6	57	44	69	0.64	本発明例
7	83	67	98	0.68	本発明例
8	101	70	132	0.53	本発明例
9	106	73	138	0.53	本発明例
10	125	79	170	0.46	本発明例
11	214	150	278	0.54	比較例
12	230	159	301	0.53	比較例

[0030]  
[Table 3]

試料	マトリクス 平均粒径 ( $\mu\text{m}$ )	表面部 マトリクス 平均粒径 ( $\mu\text{m}$ )	中心部 マトリクス 平均粒径 ( $\mu\text{m}$ )	表面/中心 マトリクス 平均粒径 比率	備考
1	9	8	9	0.89	本発明例
2	11	10	12	0.83	本発明例
3	12	11	12	0.92	本発明例
4	—	—	—	—	本発明例
5	12	10	13	0.77	本発明例
6	11	8	14	0.57	本発明例
7	16	15	17	0.88	本発明例
8	—	—	—	—	本発明例
9	17	16	17	0.94	本発明例
10	19	18	20	0.90	本発明例
11	18	17	19	0.89	比較例
12	23	21	25	0.84	比較例

[0031](Example 2) The magnetic film was formed using the Al substrate which performed NiP plating with the target of various Co-20Cr-10Pt-5B (at%) produced on condition of Cr ground film and Table 1 on the substrate on condition of the substrate temperature of 150 \*\*, Ar pressure 0.66Pa, and DC power 500W.

[0032]In order to investigate characteristic dispersion of a magnetic film, the measuring result of the coercive force Hc which the total membrane formation time produced the film formation substrate by 5 hours with one time interval from 1 hour, and measured by VSM (vibrating sample magnetometer) is shown in Table 4. However, Table 4 expressed coercive force in case the membrane formation time of each sample is 1 hour with the relative value set to 100. By making minutely uniform the pitch diameter of a network

cell and the average crystal grain diameter of a matrix which the boride forms from Table 4 shows that stabilization of the membrane characteristics at the time of weld slag membrane formation is made.

[0033]

[Table 4]

試料	保磁力（相対値）					備考
	1時間	2時間	3時間	4時間	5時間	
1	100	100	100	99	99	本発明例
2	100	101	99	100	99	本発明例
3	100	101	102	100	100	本発明例
4	100	104	95	94	94	本発明例
5	100	98	101	102	97	本発明例
6	100	97	102	98	97	本発明例
7	100	100	103	96	97	本発明例
8	100	94	95	98	90	本発明例
9	100	102	96	96	93	本発明例
10	100	102	98	90	93	本発明例
11	100	90	91	101	87	比較例
12	100	98	102	89	88	比較例

[0034] (Example 3) the raw material of Co-20Cr-10Pt-5B (at%) -- Ta, Zr, Cu, Mo, Ti, and nickel -- respectively -- independent -- 2at% -- the target with the added presentation of phi101-mm<sup>x</sup>5mm<sup>t</sup> was produced on the casting condition and hot-rolling conditions which are shown in Table 5. Microstructure observation of the central part of the produced target is performed from the direction of a sputtering surface, and the result of having measured the pitch diameter and matrix mean particle diameter of the cell which are divided by the network currently formed with the boride of the intercept method is shown in Table 6. By controlling the construction material and ingot thickness of a mold from Table 6 shows that it is possible to make detailed the pitch diameter of the cell divided by the network currently formed with the boride.

[0035]

[Table 5]

作製方法	鋳型材質	インゴット厚 (mm)	圧延率 (%)
A	Cu	30	25
B	Cu	40	25
C	セラミックス	40	25

[0036]

[Table 6]

試料	添加元素	作製方法	セル平均径 ( $\mu\text{m}$ )	マトリクス 平均粒径 ( $\mu\text{m}$ )	備考
21	Ta	A	35	10	本発明例
22	Ta	B	60	11	本発明例
23	Ta	C	280	19	比較例
24	Zr	A	30	11	本発明例
25	Zr	B	55	11	本発明例
26	Zr	C	270	13	比較例
27	Cu	A	45	13	本発明例
28	Cu	B	65	13	本発明例
29	Cu	C	310	22	比較例
30	Mo	A	40	12	本発明例
31	Mo	B	70	14	本発明例
32	Mo	C	320	19	比較例
33	Tl	A	35	11	本発明例
34	Tl	B	65	12	本発明例
35	Tl	C	290	20	比較例
36	Ni	A	45	14	本発明例
37	Ni	B	70	15	本発明例
38	Ni	C	330	21	比較例

[0037]

[Effect of the Invention] It became possible to supply the Co-Cr-Pt-B system target which stopped dispersion in the magnetic properties of the Co-Cr-Pt-B system magnetic film of the magnetic recording media for magnetic disk drives etc. by this invention, and became art indispensable to manufacture of a magnetic recording medium.

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